SURVEYS AND PLANS FOR COUNTY ROADS

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Before discussing methods of making plans for county roads, I want to say a few words about the value of good road plans. After several years' experience I am firmly convinced that there is a very close relation between road plans and the taxpayer's pocketbook.

Most all of our county highways are built by contract. The value of any highway contract is in direct proportion to the value of the plans and specifications, for they are the part of the contract that sets out what is to be done and how it is to be done. If the plans are indefinite and do not clearly set forth the requirements and conditions for the construction of the improvement, the value of the contract to the taxing district that is paying for the road, is far below par.

If you have given this subject of plans for roads any observation or study, you will notice that there is a close relation between road plans and road contractors. Poor plans attract a poor class of bidders, and good plans attract a good class of bidders.

As a rule poor plans are more flexible and liable to substitution than good plans. The specifications accompanying poor plans are indefinite and very often some detail of the work might be built in two or three different ways and still be open to argument as to whether the work is performed in accordance with the plans and specifications.

The unscrupulous contractor who is in the habit of slighting work and interpreting indefinite provisions of the plans to his own benefit, enjoys arriving at a letting and finding a poor set of road plans. He is quick to see loop-holes and possibilities of inferior substitutions and makes his bid accordingly.

He has some right to assume that, if the plans are prepared in a slip-shod manner, that the construction will probably be handled in the same way. Good plans always command respect and inspire confidence.

The first class contractor who is in business to stay and who likes to leave a good record wherever he works, does not care for this kind of competition, and seeks localities where plans are prepared in such a manner that the hard working and conscientious bidder has a fair show.

Surveys and Plans

In discussing methods for making plans and specifications for county roads, I have not taken up every detail of the work, but just enough of the essential operations to give a fair idea of what is required.

The survey is made for the purpose of getting information in the field and includes the accurate location of all physical and topographical features that may affect the improvement. Part of this information is obtained with instruments, such as the level, transit and tape, and part by personal observation.

The principal work to be accomplished in the survey is the location of the center line of the proposed road and the taking of levels to find the difference of elevation of points along and adjacent to this center line.

As a rule county roads in this county are located along section or fractional section lines. In making the survey no time should be spared in getting the center line of the proposed road properly located. This is the key-stone of the whole survey. Every thing else is built upon it. Personally, I spend three or four days or a week, if necessary, hunting corner stones and other monuments that determine the proper and legal location of the proposed improvement.

It is important that the plans be based upon the same center line as the one used in construction. Don't take cross sections from one center line and set slope stakes from another.

Very often there will be fences within the highway location that must be moved. The proper location of the center line at the start of the survey will save a lot of trouble and annoyance about property lines later on. If the line is established by existing corner stones and legal monuments there is seldom any complaint by the landowner when he is ordered to move his fence.

Once the ruling points on the center line are established the next work is to run the transit line, set station stakes, and take notes on topography far enough on each side of the center line to include all areas that will probably be affected by the improvement. Having located the ruling points on the line, the transit is set over the first hub stake, or corner stone and sighted to the next stake or corner stone on the line of the road. The bearing of this line is noted, also its deflection from an intersecting road at this point, if there happens to be one. Successive points on the center line at each station are now obtained by signals to the head flagman, who places his flag-pole at the proper points. If a cross section party is following the transit party it is common practice not to drive stakes every hundred feet, but to drive a small nail with a piece of red cloth attached

to it, at each station on the center line. These are easily found by the level party, and save driving stakes until construction is started.

If the levels are to be taken at some later time, off-set stakes are set at such a distance from the center line that they will not be broken or disturbed by traffic on the road. On these stakes must be marked the station number and distance to the established center line.

After setting one-quarter or half mile of stakes the transit is moved up to the next hub stake, sighted to the point just left and then sighted upon the next corner stone or hub ahead. The deflection between these two lines is noted, also the bearing of the line, station number, and distance from the last set-up.

When the head flagman comes to a bridge he takes points on the line at each end of the span and notes in a note-book the station number of each end of the span, also distances from the center line of the road to the center line of the bridge. The location of all buildings along the road are obtained by measurement and the station number of all transverse fences, both property line and field fences, are noted. The direction and location of water-courses, both open and tile, are also noted on the transit book map.

After the transit line is run and topography taken, the cross section and center line levels are obtained. A cross section party usually consists of four men, namely, a leveller, rod-man and two chainmen. In doing this work, one chainman goes to the station stake and notes the distance marked upon the stake to the center line of the road as established by the transit party. Using this distance the zero end of the tape is placed on the center line and the tape stretched across one-half of the highway. With the tape in this position the rod-man gives the center line reading and then walks along the tape selecting points that will give a good representation of the ground surface. As the rod is held and read at each point the rod-man calls out the distance of each point from the center line for the leveller to place in the note-book. The tape is then stretched across the opposite half of the highway and the operations repeated.

Where the route of the road is over the location of an already established highway, it generally requires from seven to nine level readings to obtain a representative cross-section. On new location and fairly level ground this number will be considerably reduced.

Office Work

With the transit and level work completed the scene of operations is shifted to the office. Before starting the office work it is a good plan to decide upon the form and general make-

up of the completed set of plans. Are you going to have a profile several feet long, or are you going to use small sheets of paper with several profile lines upon each sheet? Will the cross-section sheets and bridge plan sheets all be of the same size? These are some of the things you will have to decide upon. These questions are easily decided, if you use the sheets designed by the U. S. Bureau of Public Roads. These sheets are the plan-profile type and of a size that when bound together are portable and easily handled. The size of the border line on each sheet is 22x33½ inches. Thirty-two hundred feet of road can be placed on each sheet to a scale of one inch to one hundred feet.

In addition to plan and profile sheets the plan will contain a title sheet which should show a general layout of the improvement and immediate vicinity. Bridge drawings and cross sections are made upon sheets that conform to the size of the plan-profile sheets, and the whole bound together when finished.

In plotting the line there are two or three methods in common use. The most common is to plot the different tangents by means of a protractor and scale. Another method often used is the tangent method in which the line of each tangent is produced and offsets from this line computed.

The profile is plotted just below the plan. Stations are marked off on the horizontal line corresponding to the same stations upon the plan. The ground or surface line shown on the profile should represent the center line of the new improvement. The horizontal scale of the profile, usually one inch equals one hundred feet, is also used in making the plan. If the horizontal scale of the profile is one hundred feet to the inch, the vertical scale should be about ten feet to the inch.

In addition to the center line the profile should show the grade of the new road, together with elevations of grade points and elevations of grade of each one hundred feet. It should describe and give the elevation of all bench marks. The elevation of all drainage structures and the flow lines of all intersecting drains, either open or tile, should be shown on the profile.

A convenient scale for plotting cross-sections is one inch equals five feet. In plotting cross-sections the horizontal and vertical scales are the same.

With the plan, profile and cross-sections plotted, the next step is to establish the grade of the new road. Whenever possible, it is important that the grade of the road be so established that the amount of excavation and embankment will be about the same, without excessive and expensive haul. The most monotonous job, in my opinion, involved in preparing a set of road plans, is to establish a grade-line which will balance the volume of cut and fill, but I firmly believe that the extra work

required in the office is fully justified by better construction and lower and more intelligent bidding. The operations are about as follows: Having decided upon the cross-section of the new road, a cardboard templet of this section is made to the same scale as that of the plotted cross-sections. A trial grade line, say 500 or 1,000 feet long, is established by inspection and the grade elevation at each station computed. These grade elevations are marked upon the cross-sections. The templet of the new roadway is then centered upon the cross-sections at the elevation of the new grade throughout the length of the trial grade line, and a pencil run around the templet to outline the proposed roadway. After this operation is completed, you have an outline of both the new road and the old road at each one hundred feet of the trial grade. Sometimes these two outlines will be very close together; at other times they will be widely separated, depending to what extent the new grade conforms to the existing grade. The space between these two outlines represents area for obtaining volume of cut or area for obtaining volume of fill. These areas are usually mixed at each station, part representing fill, and part representing cut.

The next step is to compute the area of the cut and fill sections. This can be done by dividing the irregular areas into regular geometrical forms, such as rectangles, triangles and trapezoids and computing the area of each small figure. A much faster method, and one that is usually within the required degree of accuracy, is to use a planimeter for obtaining the areas.

The areas of cut and fill are figured separately and the average end area for any station, multiplied by one hundred and divided by twenty-seven, gives the volume of cut or fill for that station in cubic yards. If the volume of cut and fill do not balance, a new trial grade is established and the operations repeated until the amount of excavation and embankment are about the same.

I have outlined in the foregoing paragraphs the essential operations involved in the preparation of a set of county road plans. Many of the details I have not attempted to discuss, such as location curves and vertical curves; also, shrinkage, bridge plans, etc.

It pays to spend considerable time in drafting, in lettering, and in making plans neat. There is nothing that improves a set of plans like good lettering. If you can not letter yourself, hire some one that can.